Issued September 29, 1909.

U. S. DEPARTMENT OF AGRICULTURE.

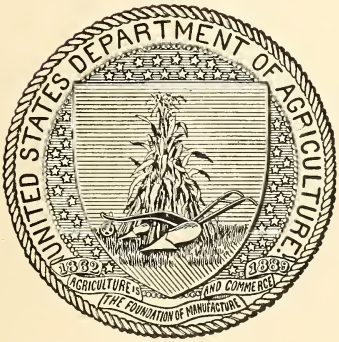
BUREAU OF SOILS—BULLETIN NO. 60.

MILTON WHITNEY, Chief.

# A PRELIMINARY REPORT ON THE VOLUSIA SOILS, THEIR PROBLEMS AND MANAGEMENT.

BY

M. EARL CARR.




WASHINGTON:

GOVERNMENT PRINTING OFFICE.

1909.

## BUREAU OF SOILS.

MILTON WHITNEY, Chief of Bureau.
ALBERT G. RICE, Chief Clerk.

### SCIENTIFIC STAFF.

FRANK K. CAMERON, in charge of Physical and Chemical Investigations.
CLARENCE W. DORSEY, in charge of Soil Survey, Western Division.
JAY A. BONSTEEL, in charge of Soil Survey, Eastern Division.
OSWALD SCHREINER, in charge of Fertility Investigations.
W J McGEE, in charge of Soil Erosion Investigations.

# LETTER OF TRANSMITTAL.

U. S. Department of Agriculture,
Bureau of Soils,
*Washington, D. C., May 19, 1909.*

Sir: I have the honor to transmit a manuscript entitled "A Preliminary Report on the Volusia Soils, their Problems and Management," by M. Earl Carr, of this Bureau. This report is based upon the information gained in soil surveys situated in different parts of the wide region occupied by the important Volusia series of soils, augmented by special study of the soil conditions in parts of the region where soil surveys have not yet been undertaken. The Volusia series of soils occupies a belt of country in southern New York, northern Pennsylvania, and northeastern Ohio, covering an area of over 10,000,000 acres. For twenty-five years the general tendency in prices of farms in this region has been downward and in some localities actual agricultural abandonment of the land has resulted. The soil conditions affecting this economic problem are discussed in this report and the facts set forth therein should result in the removal of the impression that these soils are "worn out" or inherently incapable of profitable crop production. The report should lead to a restoration of confidence concerning the capabilities of these soils, and if an increase in agricultural value of $1 an acre can thus be brought about the sum of over $10,000,000 will be involved. The report discusses fully the characteristics of these soils and their capabilities, treating briefly the general soil problems encountered and their bearing upon the economic problems of the region.

I recommend the publication of this report as Bulletin No. 60 of the Bureau of Soils.

Very respectfully,

Milton Whitney,
*Chief of Bureau.*

Hon. James Wilson,
*Secretary of Agriculture.*

# CONTENTS.



# ILLUSTRATIONS.

PLATES.



FIGURE.

# A PRELIMINARY REPORT ON THE VOLUSIA SOILS, THEIR PROBLEMS AND MANAGEMENT.

## INTRODUCTION.

The Volusia [a] series of soils occurs in a more or less extended belt, covering the glaciated portion of the Allegheny Plateau in northeastern Ohio, northwestern and northeastern Pennsylvania, and

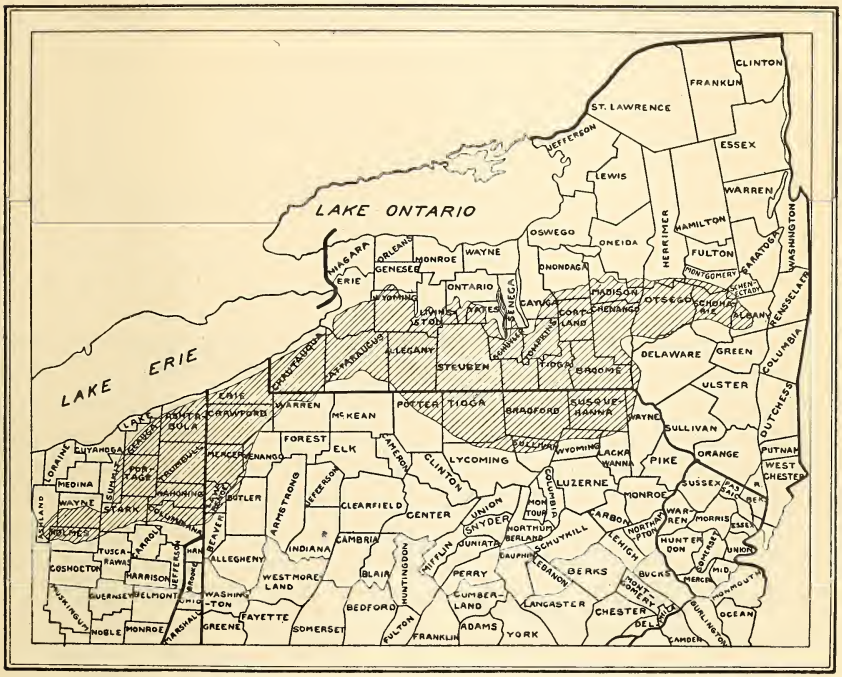



FIG. 1.—Sketch map showing the region occupied by Volusia soils in Ohio, Pennsylvania, and New York.

southern and south-central New York. These soils cover an approximate area of from 15,000 to 20,000 square miles, or something over 10,000,000 acres. They are the hill soils of the region, always being

[a] The soil series name "Volusia," adopted to identify this group of soils, is that of a small village in Chautauqua County, N. Y., where they were first encountered and mapped in 1901.

found at relatively high altitudes, while the narrow valleys occurring within the same general region are occupied by other soils and soil series, differing in origin, method of formation, structure, coloration, and other properties.

The acreage of each type of soil in the Volusia series mapped to January 1, 1909, in New York, Pennsylvania, and Ohio, and the total area for all three States are as follows:

*Area of Volusia soils mapped to January 1, 1909.*

| State and kind of survey. | Type of soil. | Area of individual type. | Total area. |
|---|---|---|---|
| | | *Acres.* | *Acres.* |
| Pennsylvania, reconnoissance survey, all types | | | 1,840,000 |
| Ohio, detailed surveys | Loam | 173,440 | 251,904 |
| | Silt loam | 78,464 | |
| New York, detailed surveys | Stony loam | 12,352 | 862,050 |
| | Gravelly loam | 13,760 | |
| | Loam | 329,954 | |
| | Silt loam | 500,032 | |
| | Clay loam | 5,952 | |
| Total, detailed surveys | | | 1,113,954 |
| Total, all surveys | | | 2,953,954 |

The area mapped comprises 4,615½ square miles, or about 25 per cent of the estimated area of the series.

## DESCRIPTION OF SOILS.

The Volusia soils are derived through feeble glaciation from shales and sandstones of Devonian and Upper Carboniferous ages. While the soil-forming material is primarily made up of material from these country rocks moved only a comparatively short distance, there is usually a small percentage of glacial material foreign to the immediate locality. In many places residual decay of the underlying rock has added largely to the material forming these soils, particularly in the case of the silt loam type. The underlying shales and sandstones are almost always comparatively near the surface. In fact, the glacial material is often so shallow that the bed rock is found within a 3-foot section, and it outcrops in not a few instances. While these Volusia soils are generally shallow, the soils occurring in the valleys are much deeper, the underlying rock often being several hundred feet beneath the surface.

The soils of the Volusia series are light colored—grays, light yellows, and light browns predominating. Where the soil is in poor condition the lighter colors are very much in evidence, there is a lack of drainage, a deficiency of organic matter, poor herbage, and a generally inert, lifeless appearance. Where the better soil conditions obtain the colors are darker and warmer, a larger content of organic

matter is present, the drainage conditions are better, better herbage prevails, and the soil is marked by a more healthy, lively appearance, all of which are reflected in larger and better crop yields. In contrast with the soils of the Volusia series the valley soils are characterized by darker colors—browns and dark grays to black being much more frequent. Natural drainage conditions are better, the organic matter content higher, and a far better quality and quantity of herbage is supported. The influences of all these differences in favor of the valley soils are shown by differences in the soil problems, by a wider range in adaptation to crops, by different types of farm industry, by better crop producing power, and finally, by a higher market value of the valley lands.

The Volusia silt loam is the most extensive type of the series so far encountered, making up about 50 per cent of the area covered by detailed surveys. The surface soil of this type consists of a gray, light-brown, or pale-yellow silt loam with a depth of some 8 or 9 inches. The subsoil is a gray or yellowish compact silt loam. Both soil and subsoil contain a varying but usually high percentage of flat shale and sandstone fragments. The physiographic features of this type of soil are characteristic. It always occurs on the hills and at comparatively high altitudes. Preglacial erosion has developed a varied topography and favored the development of an excellent system of surface drainage. On account of the hilly topography there is a considerable percentage of waste land.

The Volusia loam is the most important agricultural soil of the Volusia series. It consists of a surface loam 8 to 10 inches in depth, having a dark-gray to light-brown color and a subsoil of gray to mottled compact loam, composed of glacial till. Both soil and subsoil of this type are more or less filled with stone fragments, the sandstone and foreign rock material being somewhat greater than in the silt loam type.

This type like the silt loam has a hilly topography, though lying usually at slightly lower altitudes, and the natural surface drainage is the same. It, however, has generally a somewhat less broken topography, and waste land on this account forms a smaller proportion of its area.

The Volusia gravelly loam has a more limited area than the soils just described, but is the lightest, warmest, and earliest soil of the series. It is a gravelly loam extending usually to depths greater than 3 feet, the surface soil being as a rule light-brown in color, and the gravel content for the most part rounded and waterworn. The topography is often quite broken and rough, owing in part to the processes by which it was formed and in part to erosion subsequent to its deposition.

The Volusia stony loam is of small extent, so far having been mapped only in one area, Tompkins County, N. Y. The soil consists of a heavy dark-brown loam containing a large quantity of flat shale and also a considerable proportion of rounded stones and cobbles. The subsoil to a depth of 3 feet is a light loam, sometimes containing large quantities of stone and gravel. This soil type as so far encountered has a rolling topography particularly favorable for agricultural occupation, with a minimum percentage of waste hilly land.

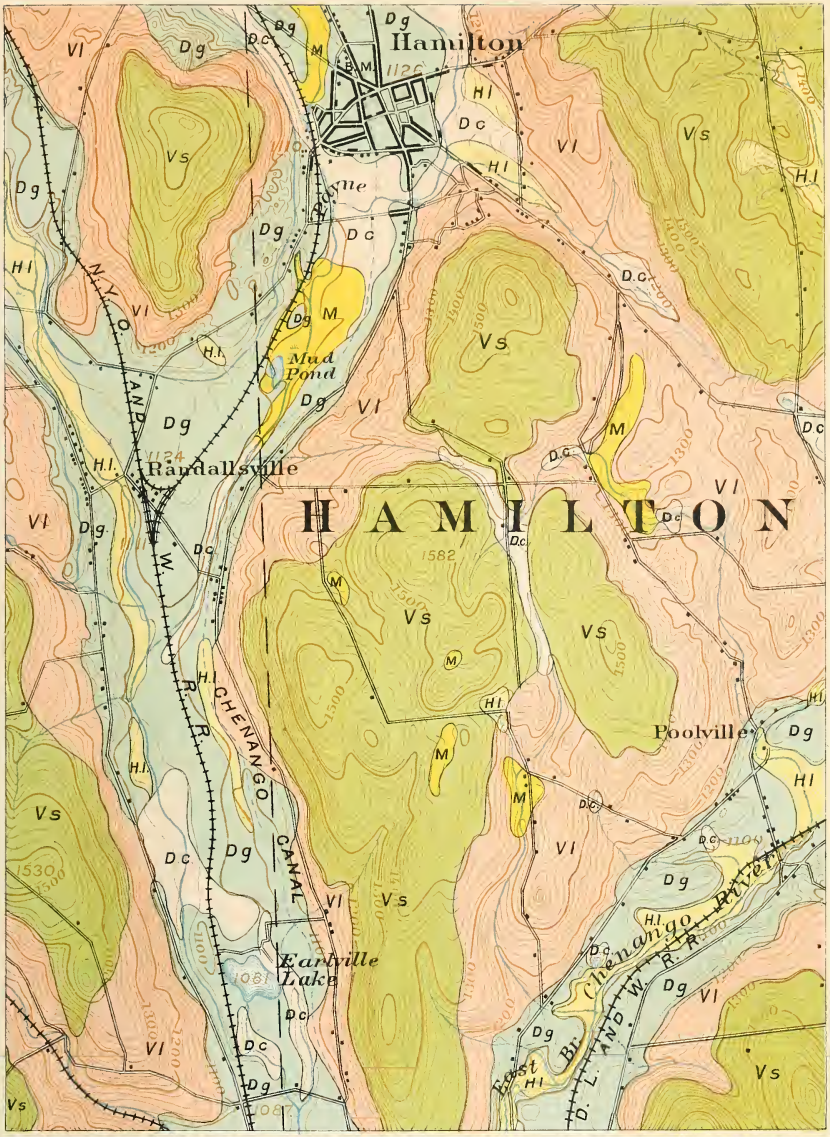
The Volusia clay loam is also of very limited extent, not having been encountered outside of Tompkins County, N. Y. It has a surface soil 6 to 8 inches in depth, of dark-yellow to brown heavy loam or clay loam, underlain by a subsoil of pale-yellow or drab clay loam. This type is rolling rather than hilly and the surface conditions are quite favorable for agriculture.

## AGRICULTURAL CONDITIONS.

The agricultural conditions prevailing over areas of the Volusia soils are not at the present time all that can be desired and certainly not all that is warranted by the inherent capabilities of the soil. This is particularly true of the silt loam and to a less degree of the loam and the other types of the series. There are soil conditions and soil problems which make the agriculture of some sections extremely poor. That these same soil conditions and problems do not obtain on the valley soils of the region or on the soils located in the lower lying region to the north of the country occupied by the Volusia soils is proved by the prevalence of much better agricultural conditions, more intensive systems of farming, the larger crop yields, and the higher prices at which these other soils are held.

When the region in which the Volusia soils occur was first cleared of its forests of chestnut, oak, white pine, sugar maple, beech, and hemlock large yields of the staple crops, wheat, corn, oats, and hay, were secured. No difficulty was experienced in the growing of red clover or other crops. The region was fairly well populated, the families large, and the farmers prosperous. However, there has developed a condition of the soil, especially in the silt loam areas, which is inimical to some forms of plant life. That this condition is a soil and not a plant problem is evident both from field observation and experimental work.

Many farms and fields can now be found where red clover and other crops still grow well, and in the same region, perhaps on an adjoining farm or field, they give indifferent results, or refuse to grow at all. The soil of newly cleared fields seldom fails to produce crops and give good yields, while adjoining or near-by fields which have been cleared and cropped for a good many years produce poor crops, or crops of no commercial value, though when first cleared and




A.B. GRAHAM CO. WASH. D.C.

LEGEND

| Vs. | Vl. | Dg. | Hl. | Dc. | M. |
|---|---|---|---|---|---|
| Volusia silt loam | Volusia loam | Dunkirk gravelly loam | Huntington loam | Dunkirk clay | Muck |

PART OF MADISON COUNTY, N.Y., SOIL MAP, SHOWING THE TOPOGRAPHY AND RELATION OF THE VOLUSIA (HILL) SOILS TO THE VALLEY SOILS

cropped they were as productive as the fields now being brought under cultivation.

A recent bulletin [a] of the New York State College of Agriculture, based upon experimental work on these soils and dealing with the failure of red clover on them, states that this failure of the clover is not due to any fungous disease of the clover plant, that it is not due to the lack of the proper kind of bacteria in the soil, or to other influences of such a character. In fact every plant problem is eliminated from the question, and the conclusion is that the soil and soil condition alone are responsible for the "clover sickness" of the Volusia soils.

Moreover, on many fields which either refuse to grow the red varieties of clover or produce poor stands alsike clover does well, and, further, a chemical analysis of the soil by standard methods shows a sufficient amount of the common plant-food elements for successful crop growth.

In recent years extreme difficulty has been experienced in seeding clover, amounting in many cases to complete failure. Corn seldom gives any yield of mature grain; wheat yields have become so low that attempts to grow this crop have been abandoned; families are small, in some school districts the population being so sparse that the schoolhouses are closed and going to ruin. In the region occupied by the silt loam many farm homes are abandoned; the farm buildings are fast going to ruin; once productive fields are abandoned so far as profitable agriculture is concerned. These fields are growing up to weeds and in a few cases to a second growth of timber, worthless except for firewood. Many of these fields are not even being utilized for pasturage, and the present tenantry make only a poor living. As a single specific example of these two conditions the following statements are given concerning an 80-acre farm of Volusia silt loam:

In 1883 this farm produced clover hay at the rate of 2½ tons per acre for the first cutting, and clover seed from the second growth at the rate of 4 bushels per acre; nearly $700 worth of grain was produced and sold, and 3 cows, 20 sheep, and a team were kept. The total yield of all crops for each of the past five seasons grown on this farm would not support more than the 20 sheep and nothing was sold. No clover is grown, and it can not be grown by the methods now in practice. On a neighboring farm property of over 100 acres the total product for the season of 1907 was two small stacks of very poor quality hay, not over 6 to 8 tons.

The first of these farms sold in 1883 for $37.50 an acre, while in 1909 the second farm, which is neither better nor worse, was sold for about $5 an acre. A number of farms have recently been sold in this same region for taxes and brought only a few dollars an acre.

[a] Bul. No. 264 Cornell Univ. Agr. Expt. Sta., by J. H. Squires.

These figures are a fair sample of the worst conditions both as to decline in crop yields and depreciation of farm-land values in the region occupied by the Volusia soils.

The decrease in rural population referred to above, amounting to 1,015 for the past forty years and 923 for the past twenty-five years, or about 15 per square mile, is vividly shown by the following census figures for the township in which the two farms mentioned are located:

*Decrease in population of a township occupied largely by Volusia soil.*

| Year. | Census. | Population. |
|---|---|---|
| 1865 | State | 2,700 |
| 1875 | do | 2,524 |
| 1880 | Federal | 2,608 |
| 1890 | do | 2,215 |
| 1892 | State | 2,195 |
| 1900 | Federal | 1,902 |
| 1905 | State | 1,685 |
| Decrease in forty years | | 1,015 |
| Per cent decrease in forty years | | 37.6 |

These figures, while representing extreme conditions, clearly indicate the trend in some parts of the region occupied by the Volusia soils.

That these unfavorable circumstances are unnecessary is evidenced by the existence of conditions which are the exact reverse of those cited. In the same region, on a soil identically the same and in the same poor condition, producing no clover, and yielding one-half ton of hay per acre in 1907, 1 acre produced 250 bushels of potatoes without fertilization of any kind in 1908. In other sections covered by soils of the Volusia series, clover gives good yields and the yields of other crops adapted to the soils are excellent. On individual farms the farmers are prosperous and land values are not depressed and the rural population is not decreasing, but is either stationary or slightly increasing. These favorable conditions are all encountered in regions where the adaptation of the Volusia soils to the production of Irish potatoes has been recognized and put into practice, and on farms where a goodly number of live stock are kept and fed, and where drainage conditions are better. The first point is vividly shown in Steuben County, N. Y., where these Volusia soils have made the county the third potato producing county in the country. This county is also the only strictly rural county in New York which showed an increase in farm value for the two decades, 1880 to 1890 and 1890 to 1900.

The important soil problems presented by the Volusia soils can be considered under five heads—physical condition, drainage, organic matter constituents, acidity, and so-called "clover sickness."

## PHYSICAL CONDITION.

When these soils were first cleared and in their virgin state, the physical condition was favorable for the successful growth of many different crops, but with the continuous cropping to which they have been subjected, the methods of farming followed, and the systems of soil management practiced, the physical condition has changed and is now to a large extent unfavorable for the production of the same crops.

The texture of the loam and silt loam types is not particularly favorable for many crops. The average for 10 samples of the silt loam shows about 80 per cent of silt and clay and about 20 per cent of coarser material, about half of which is very fine sand, only one degree removed from the silt in fineness. Considering the textural feature apart from all other factors, it is favorable to puddling and baking, and as a matter of fact this tendency is decidedly pronounced wherever the influence of some other factor or set of factors is not present to have a counteracting effect.

The structure of both of these soil types, especially in areas which are in the poorer condition, is not as favorable for crop growth as when they were first cleared or as it is in many soils of similar and even heavier texture but of different origin, coloration, and other physical characteristics. Flocculation of the soil grains seems to be entirely lacking, and consequently the puddling and baking of the surface take place easily. A granular structure and its attending effects would facilitate desirable and beneficial moisture movements, aeration, and oxidation, all of which are necessary for the production of even ordinary yields of our farm crops. Such structure should be attained by proper drainage, liming, and the incorporation of organic matter. Another feature in connection with the structure of these soils is the occurrence of a "hardpan" in the subsoil. This hardpan is often quite near the surface and limits the depth of the surface soil and seed bed and consequently the root development of all crops, except those which are very shallow rooted, like alsike clover. It often occurs at 12 to 24 inches beneath the surface, and while its occurrence at this depth does not affect the depth and preparation of the seed bed it does have a decided effect on the root development, similar to that where it occurs nearer the surface, through its influence on soil moisture conditions.

This hardpan of the Volusia soils is not unlike the remainder of the section in texture, but consists of a compacted stratum having a dense, close structure. In not a few cases its development has at least been aided by continuous plowing at the same depth year after year. It is also brought about by plowing the soil when the subsoil is too wet, even though the surface soil may have become sufficiently

dry for tillage. By these practices the plow sole has pressed the soil grains together each time it has passed along, until finally a dense, impervious structure has been formed just beneath the surface soil, resulting in the compacted stratum called "hardpan." This layer holds the water above it in wet weather and prevents its rise from below in times of drought.

### DRAINAGE.

Although the natural surface drainage of the Volusia soils is well developed, as previously stated, the internal drainage is often poor and inefficient. Both the texture and structure of the soil are unfavorable to the free movement of soil moisture. The puddling, previously discussed, either prevents the passage of drainage water and capillary soil moisture or confines their movements to a very limited space. The hardpan also restricts greatly the vertical moisture movements. The influence of all three of these factors combined is such that only a little excess of meteoric waters is necessary to waterlog completely the section overlying the hardpan subsoil and to bring about a condition extremely unfavorable for domesticated plants.

It is likewise true that the same factors prevent the absorption and retention of a sufficient amount of moisture to tide the crops over periods of drought, and consequently only a slight deficiency of rainfall is necessary to bring about conditions as unfavorable to crop growth as the other extreme of saturation. Furthermore, there is a very poor development of natural drainage channels within the soil itself.

All these characteristics combined make the drainage conditions of the Volusia soils poor and consequently the heavier soils of the series are much in need of artificial drainage.

### ORGANIC MATTER.

Another soil problem in connection with the Volusia soils is that of organic matter, which is of great importance in crop production. That this is a soil and not a plant problem is shown by the different forms organic matter assumes in decaying in different soils, by the different rates of decomposition in different soils, and finally by the varied effects it has upon further plant growth in different soils.

It has been observed that the decay or partial decay of organic matter in many soils results in dark and warm colors and that its favorable effects persist for long periods of time, but that when this decay of organic matter takes place in the Volusia soils the resulting colors are not so dark and the resultant favorable effects are not of so long duration. It may be that the decomposition of organic matter in some soils results to a considerable extent in solid carbonaceous

products with a minimum of gaseous matter, while the decomposition in other soils, like the soils in question, results largely in gaseous products with a minimum of the carbonaceous forms.

### ACIDITY.

In regard to the chemical condition of these soils it is evident that there has been developed an acid condition, which makes the production of certain crops most difficult and which has led in many instances to the abandonment of attempts to grow them.

The accumulated effects of all of these unfavorable soil conditions have been, it is believed, the chief cause of the decline of productiveness of considerable areas of these soils, leading to the abandonment of fields, the desertion of farm homes, and the consequent decrease in population and diminution in farm land values.

### "CLOVER SICKNESS."

In connection with the problems discussed there is another soil problem, the cause of so-called "clover sickness" and its remedy. While the bacterium necessary to the thrifty growth of clover is present in the soils, the poor physical condition and attending poor internal drainage conditions, together with the low organic matter content and soil acidity, result in conditions inhibitive of its development and activity. In the Volusia soils the drainage features, character of organic content, and degree of acidity are all particularly inimical to the beneficial forms of bacteria. Coincident with these conditions is the "clover sickness" of the soil. There are large areas within these soils where red clovers fail to grow, though they once were produced abundantly without difficulty, both for hay and seed. As a matter of fact the red varieties of clover will not grow naturally, and can not be made to grow where all the conditions mentioned obtain and rarely where they exist singly.

In some sections of the country "clover sickness" is purely a plant problem, but in the case of the Volusia soils it is purely a soil problem. Fungous diseases, the root borer, the absence of bacteria, in fact, all plant problems connected with its failure, have been eliminated, and the whole question hinges directly upon the physical, mechanical, and chemical condition of the soil. When these unfavorable soil conditions are overcome clover will grow, and it will not grow successfully until they are overcome.

Various reasons have been assigned for the present poor and extensive type of agriculture followed on the Volusia soils where these unfavorable soil conditions have developed. Chief among these reasons is that the soils are "worn out." Distance from markets, poor transportation facilities, isolation of the sections in which

the soils occur, poor schools, and unfavorable social conditions have all been suggested as causes of the decline of agriculture in the region. The fact remains, however, that the soils are not exhausted in any reasonable sense of the word. They are not "worn out," but are still capable of producing abundant yields of those crops to which they are adapted, if certain unfavorable soil conditions are remedied and proper tillage and soil management methods are employed. The distance from markets is less than it was when, in the early days, the whole region was still prosperous. The markets are better than ever before. The means and facilities for the transportation of the products of these soils are far better and more efficient than in the pioneer days. The isolation is much less than formerly, and is diminishing by reason of better roads, rural free delivery of mail, rural telephone lines, more and better steam and trolley roads, nearer and larger villages and cities, and the use of horses instead of oxen.

We must concede that these changes for the better have taken place, while at the same time agricultural conditions have been growing worse, though undoubtedly it is a matter of fact that the condition of the schools, of the churches, and of other social institutions has visibly declined with the decline of agriculture in many sections. However, when we analyze clearly the whole situation with reference to these soils we can arrive at no other conclusion than that the fundamental problem is a soil question and that the social and economic problems are only incidental and resultant problems, for they have not developed on some other soils which are just as unfavorably located.

## THE USES OF THE VOLUSIA SOILS.

The types of agricultural industry for which the Volusia soils can be profitably used are somewhat varied. However, no line of farming should be introduced which does not include animal husbandry in some form, either as a principal or subordinate feature of the farm practice.

The Volusia silt loam is adapted to the production of late Irish potatoes, oats, buckwheat, and hay. Alsike clover and timothy should be used for grass seeding, except where the soil is in better condition and no difficulty is experienced in growing red clover. Meadows in good sod will yield from 1½ to 2½ tons of hay per acre, though this yield is far above the average for the type as a whole. The timothy is always of excellent quality. However, where the soil is in poor condition there is extreme difficulty in securing a stand of the tame grasses and clovers and difficulty in maintaining the sod also. Of the grasses, redtop does best where these conditions prevail. Permanent sods soon become infested with weeds and wild grasses;

A Volusia Silt Loam Field.

Note the excellent stand of red clover in the foreground and the scant herbage, not enough to cover the ground, in the back part of the field. The whole secret here is, one part of the field was top dressed with stable manure and the other was not.

AN UNOCCUPIED VOLUSIA SILT LOAM FARM.

This plate shows the general lay of the land on the top of the high hills occupied by the Volusia soils. Note the gently rolling surface, favorable to the use of all kinds of farm machinery. Note also the two small haystacks at the left, the total product of this farm for the season of 1907, and the poor herbage in the foreground. These fields were neither mowed nor used for pasturage.

in many places "poverty grass" (*Danthonia spicata*) takes complete possession of the soil. This variety of herbage has but little feeding value either for hay or grazing. In other places on the high hills permanent sods are becoming filled with the devils paint brush or orange hawk weed, completely ruining the sod for either pasture or meadow.

Oats are an excellent crop, though the average yield is not as high as the soil is capable of producing. Yields of improved varieties have in recent years exceeded 50 bushels per acre, though the average is likely not more than 20 to 25 bushels per acre.

Buckwheat is especially suited to this soil type and with reasonably good care yields from 12 to 25 and even 30 bushels per acre. A large acreage is grown, much of which is planted on fields where other crops have failed to make a stand, or where the poor drainage conditions have prevented preparation for earlier crops.

Late Irish potatoes should generally form the main money crop of the rotations on farms of this soil type. The quality of the potatoes grown on this soil is unsurpassed, and the yields are comparatively larger than are those of other crops. The average yield per acre ranges from 100 to 150 bushels, though it is not impossible to secure, and many potato growers are securing, as high as 200 bushels per acre or more with strong seed, judicious fertilization, and improved methods of culture.

Corn for ensilage, an important product in connection with dairy farming, usually does well, but it is not to be considered for the production of grain unless some particularly early variety is planted. Mangelwurzels, carrots, and rutabaga turnips are excellent crops for this soil and can well take the place of some of the grain crops. They furnish excellent feed for dairy cattle and sheep.

Sweet corn, pease, and string beans for canning make excellent money crops where the haul to canning factories is not too long.

Where drainage conditions are favorable and the bed rock is not too close to the surface, well-selected areas are suited to apple orcharding if varieties are selected which are adapted to the soil, but the setting of fruit trees can not be recommended upon the poorer areas, even though other conditions are favorable.

The Volusia loam is a better soil for general farm crops than is the silt loam. It is usually better drained and deeper. This type is adapted to the production of potatoes, hay, oats, corn, buckwheat, and tree fruits. It is also a good soil for dairy farming and stock raising.

In the production of potatoes it is a little more sure than is the silt loam and the yields will likely average a little higher. Sod land usually produces better crops of hay, there being much less difficulty experienced in growing clover and other legumes. The sod

remains in good condition longer and the weeds are not able to crowd out the tame grasses so easily. Meadows in good condition will yield 2 to 2½ tons of good quality of hay annually, and when plowed for the intertilled crops give a better seed bed than is usually the case with the silt loam. Oats are excellent both in yield and quality. An average crop will yield from 35 to 50 bushels per acre, with an excellent quality of straw for feeding or bedding. Corn is a much surer crop than when planted on the silt loam, the average yield being from 50 to 75 bushels of ears per acre, with a quantity of dry stover. Buckwheat usually gives a yield about one-third greater than it does on the silt-loam type.

The culture of apples in farm orchards is general on the Volusia loam, and orcharding might well be extended on a commercial scale, provided the location of orchards is made with care and varieties are used which are suited to the particular soil.

Dairy farming and stock raising are industries well suited to this soil and should be developed on a larger scale than they now are.

The Volusia gravelly loam is the lightest, warmest, and earliest type of soil of the series. It is suited to the production of hay, corn, potatoes, etc. It is the best corn soil of the series and seldom fails to produce a good crop. Potatoes also do well. Excellent clover can almost always be grown.

The Volusia clay loam is well adapted to the production of hay, though the clover often "heaves" out.

The Volusia stony loam is a good general farm soil adapted to the growing of such crops as hay, oats, and buckwheat. These crops yield as follows: Hay, 1 to 2 tons; oats, 25 to 40 bushels; buckwheat, 15 to 25 bushels. The tree fruits also do well on this soil type.

Within the whole region occupied by these soils there are certain areas of waste land which should be used for forestry. Many of these areas, from the nature of the surface, are unfit for crops requiring intertillage and are covered with a generally poor growth of timber. This waste land amounts to about 12 per cent of the total area of the region, including both hills and valleys. Many other areas, now included in hillside pastures or abandoned fields, should never have been cleared, but should have been left in forest to furnish a continual income instead of being cleared, cultivated for a time, and then abandoned, producing no income at all. All these areas can be profitably reforested to such valuable timber trees as chestnut, white pine, and hemlock.

## IMPROVEMENT OF VOLUSIA SOILS.

Underdrainage is one of the most important steps in the improvement of the Volusia soils and should precede any attempt at building up these soils in other ways. A large percentage of the Volusia silt

A VOLUSIA SILT LOAM HAYFIELD.

Excellent yield of timothy and alsike clover.

ONE OF THE UNOCCUPIED FARMHOUSES ON THE VOLUSIA SILT LOAM.

This Volusia silt loam property, consisting of 18 acres, is not used for any purpose whatsoever. Directly across the highway are two Volusia silt loam farms of about 150 acres each, which are unoccupied and not producing an income more than sufficient to pay expenses and taxes, while some neighboring farms of the same soil are producing good crops.

loam type is greatly in need of this improvement. Although this soil type is rolling to hilly in character and surface drainage is well established, subsurface drainage and internal moisture movements are effected only with extreme difficulty. The texture and structure previously discussed combine to prevent to a large extent these necessary moisture movements. And finally, there are many wet areas upon the hillsides, caused by the welling up and out of water from the stratification and joint planes of the underlying bed rock and by seepage from higher levels. Then, too, some portions of the type occupy flat-topped elevations, which are almost always too wet for profitable cultivation unless artificially drained.

But one reason exists to prevent the complete underdrainage of the Volusia silt loam, and that is more apparent than real; that is its low selling value, which is in many cases less than the initial cost of the necessary drainage improvement. However, thorough underdrainage would not only result in increased quantity and better quality of the crops grown, but would greatly enhance the value of the land. It would cause new water courses to be formed within the soil. It would aid in improving the present unfavorable structure of the soil and make possible better aeration and oxidation. All these changes will result in more favorable conditions for bacterial activity and for the development of the favorable humus content of the soil.

The Volusia loam, while not so badly in need of drainage, would respond to such improvement with greater yields and a better quality of crops. The Volusia stony loam and clay loam stand in about the same relation to this improvement as does the loam. The Volusia gravelly loam is of an open structure and loose texture and consequently is well drained naturally.

Following drainage, the next step in the improvement of the Volusia soils should be the incorporation of organic matter with the soil. Suggestions in this connection are particularly applicable to the silt loam type, but are also of value to a greater or less degree if applied to the other types of the series.

When these soils were first cleared and produced good crops the humus content was fairly good, but with the systems of soil management and cropping given them and the changes which have taken place in them the organic matter content has been reduced to a minimum. That this has an important effect upon the yield of crops is certain. A larger content of organic matter would not only aid in securing and maintaining a better soil structure but would also enable the soil to retain and deliver throughout the growing season larger quantities of water to the growing crops. It would make the range of moisture content under which tillage could be undertaken wider, as well as lessen the chance of damage from an excess of water in the

early part of the season and a shortage during the dry periods in late summer and fall. It would also give rise to more favorable conditions for the activities of soil bacteria.

There are several methods by which this restoration of organic matter to the soil can be accomplished. The most common method is likely the best of all—the liberal application of stable manure. It has been demonstrated by laboratory work that the organic matter content of stable manure is more beneficial in the economy of crop production than is either the mineral content of the manure or any of the inorganic manures. Therefore much more can be accomplished in the improvement of these soils by the use of stable and organic manures than can be brought about by the use of the commercial fertilizers alone. In this connection, no forage crops should be sold from the farms of the Volusia soils; the sale products should always be those which can be marketed in a concentrated high-priced form or in a form containing a large amount of watery matter and a small amount of solid matter. In the past the practice has been largely the reverse of that advocated here, many forage and grain crops having been grown and sold. This practice has succeeded in almost completely exhausting large areas of the Volusia soils of their original stores of organic matter and in many cases almost nothing has been done by the tillers of the soil either to maintain or restore this organic matter, without which no successful crop production can be realized.

As before stated, care should be taken to return in the form of stable manure as much as possible of the crops produced by the soil. This should be augmented wherever and whenever practicable by the practice of green manuring, the growing and turning under of such crops as buckwheat, rye, clover, etc. Wherever possible leguminous crops should be grown, thus increasing the nitrogen in the soil, the most costly of all the ingredients of the commercial fertilizers.

Coincident with efforts to increase the organic content of the Volusia soils should be an effort to correct other unfavorable conditions of the soil. In this connection the use of lime is manifestly of prime importance. Lime alters existing chemical conditions, making the soil more favorable for bacterial life and a better home for the legumes. It will interact chemically with the soil-forming minerals, rendering more readily available some of the materials necessary for plant growth, but at present locked up in chemical combinations which normally withhold the elements needed by the plant. It will also aid in establishing and maintaining a physical condition of the soil more favorable to crop production. It is believed too that the presence of lime has the effect of causing the decaying organic matter to take more permanent forms and to be more beneficial in its effects upon plant growth. As a matter of precaution the application of

ANOTHER FARM WITH THE HOUSE AND BARN GOING TO DECAY.

This farm is rented by a neighbor at a nominal figure. The buildings are going to ruin and the fields producing only low yields. Note the favorable lay of the land for the use of farm machinery.

A VOLUSIA SILT LOAM POTATO FIELD.

This man with an annual acreage of 10 acres is securing an average yield per acre of over 200 bushels of late Irish potatoes of unsurpassed quality, while the average yield for the county in which the farm is located is less than 100 bushels per acre, including the production of the valley soils supposed to be more productive.

BUCKWHEAT ON VOLUSIA SILT LOAM.

Note the favorable lay of the fields, the excellent stand of buckwheat. This crop was planted on a field after corn had failed to make a stand, thus preventing loss of the use of the land for the season.

lime to the soil should never immediately precede the use of the soil for potatoes. The best place to use it in the rotation would be with or immediately preceding the seeding for sod.

Another means of improving the Volusia soils, and this applies equally to all types of the series, is deeper plowing, more thorough harrowing, and subsequent better cultivation of all of the intertilled crops. This would result in increasing the crop-producing power of these soils many fold. By more thorough stirring of the soil better aeration is accomplished, more thorough oxidation is brought about, and a better sanitary condition of the soil maintained, which will result in a better home for growing crops. By thoroughly pulverizing the soil the areal surface of the soil grains exposed is made infinitely greater than when the soil is incompletely prepared. In the former case the ability of the soil to store up and deliver moisture to the growing crops is much greater, and the feeding surface for the roots is increased also.

The last suggestion for the improvement and use of the Volusia soils is by no means the least important—that is, the utilization of each type for the production of only those crops to which it is especially adapted. Given these crops, systematic rotations should be worked out for each farm or field. In determining these rotations the fact must be constantly held in mind that the selection is not only limited to such crops as are adapted to the soils, but that the question of the distance to shipping point or market also restricts the choice. Where the farm is remote from a shipping point or market, or where the roads are poor, rough, and hilly, the rotation should include only those crops which can be marketed in a concentrated form easily transported or those which may be fed to stock, which can be driven to market. In other words, the bulky forage crops should not be sold as such but as the finished or manufactured product of smaller volume and higher price. In this way the farmer may make a profit not only on the crop grown directly from the soil, but also on the finished product, and at the same time return to the soil much of the elements necessary for crop production.

## SUMMARY.

The soils of the Volusia series are not "worn out" in any proper sense of the word, but so far as the mineral matter of the soil is concerned are abundantly supplied with the plant-food elements for the production of good crops.

The difficulties encountered in crop production upon the Volusia soils arise chiefly from lack of drainage, poor physical condition, and a depletion of organic matter.

The proper management and tillage of these soils require tile drainage over considerable areas of the more clayey soil types, plow-

ing to depths varying with the character of crop to be planted and the existence or nonexistence of hardpan, plowing only when both surface soil and subsoil are sufficiently dry to prevent puddling, the addition of organic matter in the form of stable manure or green crops plowed under, and the application of lime, particularly on the Volusia silt loam prior to seeding down to grass, especially to clover.

The soils of the Volusia series are well suited to dairying, stock raising, and sheep raising, which should be undertaken both for the sake of profit and for the sake of the soil.

Irish potatoes can be advantageously produced on the Volusia silt loam and Volusia loam and constitute the best "money crop" to supplement the animal industry.

The so-called "clover sickness" through the region occupied by the Volusia soils is a soil problem and not a plant problem.

To secure good stands of red clover on the soils of this series thorough drainage, good mechanical preparation of the land, the application of stable manure, and the application of lime at the rate of about 2,000 pounds to the acre are required.

While corn can not be grown for grain production at the highest elevations, silage corn can be produced at all elevations on all types of the series.

Where corn for grain can not be produced to advantage, Canada field peas and oats can be sown as a substitute.

Apple orcharding on a commercial scale is practicable on well-drained areas of the Volusia loam and Volusia stony loam and over a considerable portion of the Volusia silt loam in situations with favorable climatic conditions.

These soils constitute some of the cheapest farm lands now on the market in the United States, and their selling price in the majority of cases is below their actual agricultural value.

O

FIG. 1.—A VOLUSIA SILT LOAM FIELD.

The herbage consists of white daisies and poverty grass, *Danthonia spicata*, to the exclusion of other species. This herbage is valueless for either hay or pasture.

FIG. 2.—AN ADJOINING FIELD SHOWING A GOOD GROWTH OF RYE.

The camera case in the edge of the field is 12 inches in height.

FIG. 1.—ABANDONED FARM BUILDINGS ON VOLUSIA SILT LOAM.

Note that a part of the field has been mowed and a part left standing, the yield and quality of the hay not paying for the harvesting.

FIG. 2.—BUILDINGS ON A VOLUSIA SILT LOAM FARM IN SIGHT OF THOSE SHOWN IN FIG. 1.

Fields on this farm cut 2½ to 3 tons of timothy hay per acre the same season that the field shown in fig. 1 was left unused and unharvested.